United States Department of Agriculture
Forest Service

Sweet-Ione Ecological Restoration Project

Newport-Sullivan Lake Ranger District
Colville National Forest

Soil Resource Report

Prepared by:

Jason Jimenez
Soil Scientist
Colville National Forest
ARCPACS - Certified Professional Soil Scientist No. 37184

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1.0 Introduction

The analysis will focus on the effects of mechanical treatments including timber harvest and fuel reduction to the soil resource and comparing anticipated soil effects to Regional and Forest Plan Soil Quality Standards and Guidelines. The soil report will also focus on the effects of road construction on soil productivity, soil function, and watershed function. The use of silvicultural treatment, aquatic restoration treatments, and prescribed fire will also be analyzed in this report. The restoration treatments are analyzed but not focused on due to the low contributions to detrimental soil conditions. The intent of the soil report is to detail effects of treatments on the soil resource, estimate anticipated amounts of detrimental soil condition caused by the proposed action, and develop design criteria that reduces the total extent of detrimental soil conditions.

The Colville National Forest is proposing to conduct timber harvest, fuels treatment, and silvicultural management on approximately **9,600**-acres of an approximate **20,500-acre** planning area. There is approximately **7,900**-acres of commercial timber harvest planned and **10,300** acres of non-commercial treatment (overlapping ground with commercial treatments). (*Treatment numbers are round up to the hundred.)* Within the planning area, **9.0** miles of roads will be decommissioned, **8.0** miles of unauthorized roads will be obliterated, and **8** miles of temporary road being constructed. A approximately 5 acre gravel pit will be developed. Restoration activates to improve stream and wetland habitat are also planned. The project lies within the Sullivan Lake Ranger District within the Big Muddy Creek and Sweet Creek-Pend Oreille River watersheds.

2.0 Relevant Laws, Regulation, and Policy – Regulatory Framework

The relevant laws, guidance, and direction for the proposed project in relation to the effects on soil quality, soil productivity, and watershed function are:

2.1 Colville National Forest - Land and Resource Management Plan 1988

Directs managers to maintain soil productivity with an emphasis on protection over restoration and with detrimental soil conditions not to exceed 20% aerial extent with a bounding by the treatment unit. In addition to the Regional 20% standard (described above), the Colville National Forest Land and Resource Management Plan provides three additional soil standards (pp. 4-50):

- Skid trail spacing requirements must be specified in timber sale contracts that require tractor yarding.
- Identify areas of high soil erosion or mass failure potential and evaluate probable impacts.
- Retain organic matter to maintain site productivity.

2.1.1 Desired Condition

The desired condition is for proper soil and watershed function across a majority of the landscape. Soils should have bulk densities within 20% of natural occurring densities for proper hydrologic function and soil productivity (tree root function). Soil cover should be maintained to an extent to prevent detrimental soil erosion and maintain soil stability. Soils should have a functional level of soil organic matter inputs with considerations to maintaining the soil nutrient status to continue ecological function. These conditions should be maintained across a landscape to maintain and support ecological and watershed function.

2.1.2 Management Area

No management area specifically addresses management or desired conditions of the soil resource.

2.1.3 Special Area Designations

No special area designations specifically address the soil resource or make special designations for the soil resource.

2.2 Federal Law

The authorities governing Forest Service soil management are:

2.2.1 The Organic Administration Act of 1897 (16 U.S.C. 473-475)

Authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

2.2.2 Bankhead-Jones Act of 1937

The Secretary is authorized and directed to develop a program of land conservation and land utilization, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, , mitigating floods, conserving surface and subsurface moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare.

2.2.3 The Multiple-Use, Sustained-Yield Act (MUSY) of 1960 (P.L. 86-517, 74 Stat. 215; 16 U.S.C. 528-531)

States that the National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. This Act directs the Secretary of Agriculture to manage these resources in the combination that will best meet the needs of the American people. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

2.2.4 The National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321)

Declares it is the policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony. The Act requires agencies to analyze the physical, social, and economic effects associated with proposed plans and decisions, to consider alternatives to the action proposed, and to document the results of the analysis.

2.2.5 2.3.5 – The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (16 U.S.C. 1600-1614) (as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 472a)

States that the development and administration of the renewable resources of the National Forest System are to be in full accord with the concepts for multiple use and sustained yield of products and services as set forth in the Multiple-Use Sustained Yield Act of 1960. The Act requires the maintenance of productivity of the land and the protection of soil and water resources.

2.3 Executive Orders

2.3.1 Executive Order 11988 (flood plains) - 1977

Requires federal agencies to avoid to extent possible the long- and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities."

2.3.2 Executive Order 11990 (wetlands) - 1977

The purpose of Executive Order (EO) 11990 is to "minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands." To meet these objectives, the Order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

2.4 Other Guidance and Recommendations

2.4.1 Forest Service Manual Direction 2500 - Watershed and Air Management - 2010

The objectives of the Forest Service's soil resource management policy are to contribute to agency goals for National Forest and Grassland management by:

- Providing adequate soil resource information to help decision makers sustain ecological processes and functions so that desired ecosystem services are provided in perpetuity.
- Maintaining and restoring soil quality and soil productivity on National Forest System lands in order to implement the Land Management Plan.
- Ensuring all programs protect and maintain, or restore soil quality on National Forest System lands.

2.4.2 Region 6 - Soil Quality Standards and Soil Quality Guidelines - 1998

The following regional soil standards are thresholds beyond which soil quality and productivity is adversely impacted (USDA Forest Service, 1998). Soil Quality Standards require that a minimum of 80% of an activity area is an acceptable soil quality condition. Detrimental soil quality conditions and the accompanying criteria for determining these conditions include:

- **Detrimental Compaction** – An increase in soil bulk density of 20% or more over an undisturbed level in volcanic ash soils or an increase in soil bulk density of 15% or more over an undisturbed level in other soil textures.
- **Displacement Puddling** – When the depth of ruts or imprints is six inches or more, soil deformation and loss of structure are observable and bulk density is increased.
- **Detrimental Displacement** – The removal of more than 50% of the topsoil, applies to an area greater than 100 square feet, which is at least five feet wide.
- **Detrimental Burning** – When the mineral soil surface has been dramatically changed in color, oxidized to a reddish color, and the next ½ inch blackened from organic matter charring by the heat conducted through the top layer, applies to an area greater than 100 square feet, at least five feet wide.
- **Detrimental Surface Erosion** – Evidence of surface soil loss in areas greater than 100 square feet including rills, gullies, and/or water quality degradations from sediment or nutrient enrichment.
- **Detrimental Mass Wasting** – Evidence of landslide associated with land management activities and/or degrades water quality.
- **Organic Matter** – Should be maintained in amounts sufficient to prevent short- or long-term nutrient and carbon cycle deficits and to avoid detrimental physical and biological soil conditions. (1) Fine Organic Matter – plant litter, duff, and woody material less than three inches in diameter. (2) Coarse Woody Material – woody material greater than three inches in diameter.
- **Changes in Soil Moisture Regime** – Plan land management activities so that the soil moisture regime remains unchanged.

2.4.3 National Best Management Practices for Water Quality Management on Forest System Lands - 2012

Best management practices (BMP's) designed to protect water quality, soil quality, and watershed condition are derived from National Best Management Practices for Water Quality Management on National Forest System Lands (USDA Forest Service, 2012a). Similar projects have used BMP's in the past and been proven effective in protecting water quality, soil quality, soil and tree productivity, and watershed condition.

3.0 Topic and Issues Addressed in This Analysis

3.1 Purpose and Need

An interdisciplinary team developed the following objectives based on existing conditions and the desired conditions outlined by the Forest Plan:

- Forest Structure: Manage vegetation conditions to be more resilient to disturbance and reduce high-severity wildfire.
- Watershed Function: Improve watershed function and the aquatic systems.
- Habitat Improvement: Enhance habitat conditions for aquatic and terrestrial species.
- Economic Health: Contribute to the local economic health and stability of rural communities.
- Transportation: Assess and improve transportation system to develop a sustainable minimum road system.

3.2 Issues

There were no issues from the purpose and need that directly relate to the soil resource. There were no soil resource or watershed issues that led to the development of additional alternatives.

3.3 Other Resource Concerns

There is no other substantial resource concern in relation to the proposed action and the resource indicators and measures.

3.4 Resource Indicators and Measures

Table 1. Resource indicators and measures for assessing effects

Resource Element	Resource Indicator	Measure	Used to Address Purpose and Need or Key Issue?	Source from Law, Policy, Standards and Guidelines, or Best Management Practices
Soil Function	Detrimental Soil Conditions	Extent of Detrimental Soil Conditions in Activity Areas	No	National Forest Management Act of 1976; Regional and Forest Plan Soil Quality Standards and Guidelines
Soil Erosion	Surface Soil Erosion and Landslide Potential	Potential for Detrimental Surface Soil Erosion and Detrimental Mass Soil Movement	No	National Forest Management Act of 1976; Regional and Forest Plan Soil Quality Standards and Guidelines
Soil Organic Matter	Depth of Forest Floor, Quantity of Fine and Coarse Wood	Potential for Soil Fertility and Soil Function Issues Due to Lack of Organic Matter Inputs	No	National Forest Management Act of 1976; Regional and Forest Plan Soil Quality Standards and Guidelines
Watershed Function	Proposed Area for Disturbance of Hydrologic Function – New System and Temporary Road Construction	Acres of Additional System and Temporary Road minus Areas of Hydrologic Function Restoration (Road Decommissioning)	Yes	The Organic Administration Act of 1897; Forest Service Manual Direction 2500 - Watershed and Air Management

4.0 Methodology

4.1 Information Sources

The project area was evaluated using current soil maps, geology maps, and topographical maps as well as historical and current aerial imagery. The soil scientist focused field time and soil crew field survey on units proposed for ground based mechanical treatment.

The Soil Crew also collected **90** National Soil Disturbance Monitoring Protocol surveys in proposed treatment stands in the 2018 and 2019 field season. Soil compaction was identified by use of a spade to evaluate alteration of soil structure and other factors. Extent of compaction is determined through transects and use of visual disturbance classes (Page-Dumroese et al., 2009a, 2009b). Surveys were targeted at stands with a high likelihood for ground-based timber harvest treatments. Activity areas with previous disturbance have National Soil Disturbance Monitoring Protocol surveys completed to 70% confidence error with a 5% margin of error. Activity areas with no observed disturbance have 15 sample points completed, this prioritizes sampling of areas with soil disturbance. Field sheets and field notes are available in the project file. Photos and a GPS track are taken during each transect. Sampling with National Soil Disturbance Monitoring Protocol surveys as well as additional reconnaissance level evaluation by the soil scientists and soil technicians provides a representative sampling of the planning area for the understanding of the landscape, potential effects, and cumulative effects. A summary of disturbance is found in **Section 5.3** and **Appendix A**.

Using Groundwater Dependent Ecosystem (USDA Forest Service, 2012b) the soil crew surveyed selected mapped wetlands on Forest Service lands within the analysis area. Wetlands were also surveyed to determine if they meet criteria for hydric plants, hydric soils, and wetland hydrology. A total of **13** wetlands (approximately **90** acres) were surveyed in 2018. Results are reported in **Section 5.3** and **Appendix B**.

The analysis is conducted using geographic information, field data collection, and a review of past and current scientific literature in relation to soil formation, soil quality, soil compaction, and the effects of treatments on soil function. A review of Colville National Forest soil monitoring data as well as soil monitoring conducted on other National Forests in Region 1 and 6 also informs the analysis and conclusions.

4.2 Incomplete and Unavailable Information

There is no incomplete or unavailable information that would substantially change or modify the analysis or conclusions provided.

4.3 Spatial and Temporal Context for Effects Analysis

Direct/Indirect/Cumulative Effects Boundaries

Area – Effects on soil productivity are site specific and not spatially mobile over the analysis area. The analysis area for effects analysis to soils is the treatment unit or activity area. The activity area as defined in Region 6 Soil Quality Standards as "The total area of ground impacting activity and is a feasible unit for sampling and evaluating". The effects of past, present, and reasonably foreseeable future actions to soils typically involve the area of disturbance itself and does not move outside the area disturbed. The development and movement of soils occurs on a geologic time scale and this area bounding reflects cumulative effects to soils.

The area affected by the construction of new system roads, new temporary roads, and new excavated skid trails is detrimental soil condition between the cut and fill slopes and the area hydrologically disconnected by the road template.

Time – Disturbance to soil can last for decades and even centuries (Amundson and Jenny, 1997; Jenny, 1941). For reasonably foreseeable future actions, the bounding is five years in the future. No additional projects and treatments in addition to the proposed action is anticipated within the activity areas. Continued cattle grazing, road maintenance, special use by the Air Force Survival School, and recreational activities are anticipated to be the reasonably foreseeable future events.

The construction of new system roads is considered to impact soils, soil productivity, and hydrologic function for the long term. Soil function would be restored on a timeframe between hundreds and thousands of years due to natural processes. Construction of new excavated skid trails, new temporary roads, and new system roads essentially resets soil development to time zero.

5.0 Affected Environment – Existing Condition

5.1 Resource Indicator and Measures

Table 2. Resource indicators and measures for the existing condition

Resource Element	Resource Indicator	Measure	Existing Condition
Soil Function	Detrimental Soil Conditions	Extent in Activity Areas	350 Acres
Soil Erosion	Surface Soil Erosion and Landslide Potential	Potential for Detrimental Surface Soil Erosion and Detrimental Mass Soil Movement	Low
Soil Organic Matter	Depth of Forest Floor, Quantity of Fine and Coarse Wood	Potential for Soil Fertility and Soil Function Issues Due to Lack of Organic Matter Inputs	Low
Watershed Function	Proposed Area for Disturbance of Hydrologic Function – New System and Temporary Road Construction	Acres of Additional System and Temporary Road minus Areas of Hydrologic Function Restoration (Road Decommissioning)	0 Acres

5.1.1 Soil Function – Detrimental Soil Condition

Table 3. Estimated detrimental soil condition in proposed treatment units

Percent Detrimental Soil Condition[1]	Number of Units Sampled	Existing Condition Detrimental Soil Conditions Approximate Acres
0-3%	67	7,100
7-10%	18	1,800
10>%	5	700

Notes: [1]Estimated approximately **9,600** acres surveyed of the approximately **20,600-acre** project area, all of the units planned for treatment by ground based mechanical equipment were surveyed.

5.1.2 Soil Erosion – Surface Soil Erosion and Mass Wasting

Field surveys conducted by the Soil Crew in 2018 and 2019 did not detect the presence of soil erosion across the landscape. National Soil Disturbance Monitoring Protocol surveys conducted within treatment units recorded data on over **2,700** points. The forest floor depth averaged **4** cm across the units. The depth of forest floor prevents soil erosion and lowers the potential for detrimental soil erosion.

Recent aerial photos were reviewed for the presence of substantial soil mass movement (i.e. landslides and debris flows). Field surveys revealed active soil movement in unit 16, which exhibited signs of slumping and active sliding. The unit was re-drawn to exclude the area of active soil movement.

5.1.3 Soil Organic Matter

Field surveys conducted by the Soil Crew in 2018 and 2019 show the presence of sufficient forest floor depth as well as the presence of fine and coarse wood. Fine woody material presence averaged 90% of the sample points and coarse woody 20% of the sample points across the units which will sustain soil organic matter inputs and soil nutrient status over the short- and long-term.

5.1.4 Watershed Function

The watersheds within the analysis area have a moderate road density. Field surveys found some old non-system roads and several legacy skid trails within the field surveys areas.

5.1.5 Wetlands

Wetland areas were identified for survey to determine existing conditions using the information from the National Wetlands Inventory shapefile for the Colville National Forest. Due to time and resource constraints wetlands were prioritized for survey. Fourteen wetlands were identified for were surveyed and rated. Additional descriptions can be found in **Appendix B** and in the soils project file.

Table 4. Wetlands surveyed

Category	Number of Wetlands
Mapped Wetland Did Not Met Wetland Criteria	2
Non-Functional	0
Functional at Risk	1
Properly Functioning	11
Total	**14**

5.2 Soils in the Project Area

The soils in the project area are grouped into two categories based on their parent material and distribution of volcanic ash. Volcanic ash content has strong influences for soil productivity and sensitivity to management actions. Volcanic ash soils are typically highly productive and soil textures can be sensitive to compaction and erosion. The soils within these groups (volcanic ash-cap, no volcanic ash-cap) have similar properties and implications for management. (USDA National Resource Conservation Service, 1992)

5.2.1 Volcanic Ash Cap Soils

Soils influenced by volcanic ash dominate the soils of the Colville National Forest. Volcanic ash mainly comes from two different eruptions of Cascade volcanoes, Glacier Peak and Mt. Mazama. Glacier Peak, in the North Cascades, erupted 12,000 years ago. Mt. Mazama (now Crater Lake) erupted 7,000 years ago which is estimated to have deposited about six to twelve inches of volcanic ash in eastern Washington. In this area, the volcanic ash is generally silt-size particles. When volcanic ash is deposited, it generally covers the landscape evenly and over time, gravity, wind, and water redistribute the ash across the landscape. In general, the volcanic ash component is deeper on north aspects, higher elevations, moist vegetation associations, and in draws and convex landscape positions.

About 93% of the treatment area has volcanic ash-cap soils. In this area, the volcanic ash layer generally ranges from 4 inches to about 18 inches. The presence of volcanic ash strongly influences many of the management interpretations for these soils. Volcanic ash-cap soils have higher water holding capacity, increased soil fertility, and are more resilient to disturbance than otherwise similar soils.

Compaction: Due to fine textures, loams and silt loams in the surface horizons, volcanic ash-cap soils have a high potential for compaction. Soils with low percentages of volcanic ash have a moderate potential for compaction due to higher rock fragment percentages and a higher bulk density.
Erosion: Soils with volcanic ash-caps are not highly erodible because the ash forms water stable soil aggregates and the soil has high infiltration rates. However, when dry, these soils are dusty and non-cohesive and can be susceptible to wind erosion if large areas of bare soil are exposed. The soil erosion hazard for volcanic ash cap soils would be moderate. This conflicts with the erosion sensitivity ratings in the soil survey, which lists volcanic ash-capped soils as having a high erosion hazard. The ratings are based on soil texture and do not account for the high infiltration rates and strong soil structure development in volcanic ash soils. Soils with low percentages of volcanic ash are less cohesive and have a high erosion potential.

5.2.2 Soils with No Appreciable Volcanic Ash

About 7**%** of the planning area is rock outcrops or has soils with no appreciable volcanic ash in the surface horizon mainly alluvial soils adjacent to streams channels
Compaction: Because of the higher initial bulk density, high rock fragment content, and the greater soil strength, these soils do not compact as easily as ash-cap soils. Compaction potential is typically low to moderate.
Erosion: On the soils formed in sandy glacial outwash, erosion hazard is high and slope stability can be problematic.

5.3 Existing Condition - Effects of Past Activities

5.3.1 Timber Harvest

Stumps and old roads, indicative of past timber harvest, are found intermittently throughout the planning area. Forest Service records and aerial photos indicate that some of the National Forest land in the planning area has had timber harvest since 1930. Logging prior to the 1930s occurred in conjunction with homesteading and settlement of the area. Some harvested areas have been logged more than once. Repeated entries, especially where new roads, skid trails, and landings are used instead of existing ones, can create extensive soil compaction and soil disturbance. The length of time required for compacted soil to de-compact and recover its full function varies depending on the type of soil, the degree of compaction, and a number of other factors, ranging from 20 to over 60 years (Miller et al., 2004)

Information from the **90** field surveys for detrimental soil condition using the National Forest Service Soil Disturbance Monitoring Protocol found typically minor amounts (less than 3%) of detrimental soil condition from past harvests. Over 70% of surveyed units had between zero and three percent detrimental soil conditions.

5.3.2 Past Wildfire

The project area has experienced several past fires in the 1920's and 1930's. More recently, the Kaniksu Complex Fire burned a small 45-acre portion of the project area in 2015. No detrimental soil conditions remain after 20 years of recovery. Potential wildfire effects to soils include soil erosion, compromise of soil structure and infiltration rates as well as reductions in soil carbon, soil organic matter, and certain soil nutrients (Bormann et al., 2008; Certini, 2005; Mataix-Solera et al., 2011; Neary et al., 2005). It is anticipated that detrimental soil conditions from the 1920's and 1930s fires have recovered and is no longer contributing to current detrimental soil conditions in the analysis area.

5.3.3 Fire Exclusion

The absence of fire lowers rates of nutrient cycling and decomposition due to cooler soil temperature, lower microbial metabolism, and the buildup of thicker duff/litter layers (DeLuca and Zouhar, 2000; Neary et al., 1999). Higher leaf areas from fire exclusion reduce soil water and solar radiation slowing nutrient cycling and decomposition. Fire exclusion has also allowed grass and shrub plant communities to become forested, which would reduce organic matter input (Biswell, 1989; Sugihara, 2006). A review of literature suggests that periodic

low intensity fires do not deplete forest nutrients but enhances soil nutrient pools and soil organic matter (Johnson et al., 2013; Johnson and Curtis, 2001; Stark, 1977). Fire exclusion has altered soil properties and the soil forming factors in certain vegetation types in the planning area, but these changes are not considered to create detrimental soil conditions.

5.3.4 Recreation

Most of this area receives a low level of dispersed camping. The impacts of dispersed camping on soil and vegetation are substantial but are very limited in area thus are of limited significance at the project and landscape scale. Off highway vehicle (OHV) use was observed on all the open roads, and many closed roads. OHV use of a closed road does not affect site productivity. Roads have been designated for travel and not the growing of vegetation, so soil productivity standards do not apply. Some user-created roads and trails were observed in the planning area. User created roads impact soil by detrimental compaction and creates rutting which increase soil erosion potentials. The OHV use in the project area is not extensive and does not threaten soil productivity. Detrimental soil condition from recreation would be much less than 1% of the project area.

5.3.5 Air Force Survival School - Special Use Permit

The Air Force Survival School uses the project area for the training of primitive survival skills as well as escape and evasion training. This use involves the construction of small primitive shelters, cutting of small diameter trees, and other low impact uses in the project area. There is limited use of Forest Service system roads with utility task vehicles and pick-up trucks by the instructors of the training programs. Some user created trails and concentrated use areas (typically camps) were observed during survey. Limited detrimental soil conditions in these areas do not pose a threat to soil quality or soil productivity and are not large enough in extent to quantify.

6.0 Environmental Consequences –

6.1 No Action Alternative

Direct and indirect effects (40 CFR 1508.8), and cumulative effects (40 CFR 1508.7) result from the proposed action, and thus are not relevant to No Action Taken. Resource indicators and measures for Alternative 1 are described in the existing condition section of this report – Section 5.0.

Table 5. Resource indicators and measures If No Action Taken

Resource Element	Resource Indicator	Measure	If No Action Taken
Soil Function	Detrimental Soil Conditions	Extent in Activity Areas (Acres)	350
Soil Erosion	Surface Soil Erosion and Landslide Potential	Potential for Detrimental Surface Soil Erosion and Detrimental Mass Soil Movement	Low
Soil Organic Matter	Depth of Forest Floor, Quantity of Fine and Coarse Wood	Potential for Soil Fertility and Soil Function Issues Due to Lack of Organic Matter Inputs	Low
Watershed Function	Proposed Area for	Acres of Additional	0 Acres

Resource Element	Resource Indicator	Measure	If No Action Taken
	Disturbance of Hydrologic Function- New System and Temporary Road Construction	System and Temporary Road minus Areas of Hydrologic Function Restoration (Road Decommissioning)	

6.1.1 Soil Function - Detrimental Soil Conditions

A slow rate of natural recovery for units with detrimentally compacted soils (20 to 60 years) would continue (Miller et al., 2004; Rab et al., 2005). Compacted soils (reduced macro-porosity) in existing legacy skid trails and other soil disturbance would slowly increase their porosity due to biological activities and thereby regain lost soil productivity over the next 20-60 years. Existing old non-system roads would remain, as they currently exist with slow recovery over a decade or century scale. Over time existing detrimental soil conditions would recover and not be present on the landscape. Currently the extent of detrimental soil conditions on the landscape does not affect soil function.

6.1.2 Soil Erosion – Surface Soil Erosion and Landslide Potential

The rate, size, and frequency of surface soil erosion and mass wasting events would not change with the no action alternative. Soil cover and soil hydrologic function would not change with the no action alternative except for the occurrence of high severity wildfire. In the current fuel loading character of the project area, high severity wildfire would substantially change soil erosion and landslide potential.

6.1.3 Soil Organic Matter

Depth of forest floor, quantity of fine, and coarse wood will continue to accumulate. Quantities will continue to accumulate above the historic range of variability in fire dependent ecosystems. Nutrient cycling would be maintained as fine organic matter increases in the duff/litter layers. Soil fertility would be maintained in units due to the accumulating organic matter on the soil surface and in the soil. The natural rates of soil microbial processes and nutrient cycling would continue with no detrimental impairment. Fire is a factor that contributes to soil formation as well as to its degradation in much of the western United States (Taskey and Arroues, 2006). The lack of fire in fire dependent ecosystems and those effects on natural soil processes is unknown. In non-fire dependent ecosystems, soil organic matter will continue to accumulate and cycle without impairment.

6.1.4 Watershed Function

Watershed function would continue the current trend. Areas of declining function identified for treatment in the proposed action would not recover in the long term and would continue to trend downward until a new natural state is achieved. These areas include roads planned for decommissioning, and stream and culvert features proposed for improvement and restoration. Areas of proper functioning would not be disturbed by the proposed road construction and removed from productivity. The current trend of watershed function would continue with potential of improvement through natural recovery.

6.1.5 Other - Nutrient Cycling, Filtering and Buffering, and Soil Carbon Storage

Nutrient cycling would be maintained as fine organic matter increases in the duff/litter layers. Soil fertility would be maintained in units due to the accumulating organic matter on the soil surface and in the soil. The natural rates of soil microbial processes and nutrient cycling would continue with no detrimental impairment. Fire is a factor

that contributes to soil formation as well as to its degradation in much of the western United States (Taskey and Arroues, 2006). The lack of fire in fire dependent ecosystems and those effects on natural soil processes is unknown.

Fuel loading without natural fire processes would continue to occur with increasing potential for a high severity fire to cause detrimental impacts to the soil quality and soil productivity. The effects of high severity wildfire are well documented in literature (Neary et al., 2005), effects can be much more severe than properly managed fuel reduction treatment. High severity fire has the potential to remove topsoil, degrade soil structure, infiltration, and water holding capacity, as well as remove soil carbon (Bormann et al., 2008). In the event of a wildfire, these effects would reduce ecosystem recovery rates and overall make the ecosystem less resilient to future disturbance.

6.1.6 Fire Exclusion

We have altered the nature of fire, fire regimes, and disturbance in forested ecosystems. The Colville National Forest has a history of large high severity fires. Stands need to be maintained at fuel loading and stand structure that is resilient and supports fire without uncharacteristic mortality or severity. Soil productivity and soil quality at the landscape scale would not be maintained by keeping the fire regime and potential vegetation outside a condition that is resilient to active fire and increasing moisture stress from drought. These conditions have potential for larger scale, greater severity disturbances, and the shifting climate with changes in temperatures and soil moisture could result in detrimental soil conditions expanding and exceeding Regional Soil Quality Standards and Guidelines and Forest Plan Standards.

6.2 Proposed Action

6.2.1 Project Design Features

6.2.1.1 General Project Design Features

- The total acreage of all detrimental soil conditions should not exceed 20% of the total acreage within the activity area including landings and system roads. The desired outcome is to limit detrimental soil conditions to preserve soil productivity and comply with Regional Soil Quality Guidelines and Forest Plan Standards. Applies to all management activities: timber harvest, fuel reduction, and prescribed fire.
- Skid trail spacing must be specified in the timber sale/stewardship contract as follows. Applies to timber harvest and fuel reduction activities.
    - Skid Trail Spacing: 100 feet apart edge to edge, except when converging at landings or avoiding obstacles.
    - Forwarder Trails: 50 feet apart edge to edge except when converging at landings or avoiding obstacles. Four to eight inches of uncompacted slash should cover forwarder trails.
- Skidding equipment must travel on designated trails. When feasible re-use old skid trails. Feller-bunchers should concentrate use on skid trails and should travel in an efficient manner with limited passes off skid trails. The desired outcome is to limit detrimental soil conditions to preserve soil productivity and comply with Regional Soil Quality Guidelines and Forest Plan Standards. Applies to timber harvest and fuel reduction activities.
- Slope limitations for ground-based equipment as follows. The desired outcome is to limit detrimental soil conditions to preserve soil productivity and reduce erosion potential. Applies to timber harvest and fuel reduction activities using mechanical equipment.
    - Tractor and skidder yarding would be limited to slopes less than 35%.
    - Feller bunchers, harvester-forwarder systems, and other tracked heavy equipment would be limited to slopes less than 40%.

  - Short slope lengths less than 200 feet may be steep. The intent of this guideline is to access larger areas above a steep slope. It is not intended to be used to directly treat large areas of steep slopes with ground-based equipment.

- Minimize compaction, rutting, and erosion by avoiding activities during wet conditions. Ground based equipment would operate on relatively dry soils of high soil strength or bearing capacity. Rutting exceeding soil quality standards should be remediated. The Field Guide to Soil Moisture Conditions Relative to Operability of Logging Equipment (Rust, 2005) should be used to determine soil trafficability. The desired outcome is to limit detrimental soil conditions and comply with Forest Plan and Regional Soil Quality Standards.
- Winter logging requires that skid trails are buffered by at least 8 inches of compacted snow or frozen ground or a combination of the two that exceeds 8 inches. If cut to length equipment is to be used, a combination of slash, compacted snow, and/or frozen ground that exceed 8 inches can be used to buffer forwarder trails. The desired outcome is to limit detrimental compaction and rutting to preserve soil productivity and soil quality. Applies to timber harvest and fuel reduction activities using mechanical equipment.
- Decompact landings and temporary roads to restore hydrologic function. The desired outcome is to restore infiltration, provide soil cover, and stabilize soils to prevent erosion and loss of soil productivity. Applies to all timber harvest activities.
- Excavated skid trails will be constructed and repaired in a manner that maintains soil hydrologic function and soil productivity. Repair will decompact the running surface of the skid trail and re-establish the contour of the slope. Soil cover will be re-established to at least 50%. Site should be evaluated for seeding and/or planting. The desired outcome is to re-establish soil productivity. Applies to all timber harvest activities.
- In units that have had commercial harvest, keep follow up fuel treatment machinery to designated skid trails except for limited passes off designated skid trails. Fuel reduction machinery (i.e., masticators and piling equipment) should be tracked equipment having a ground pressure rating of 8 psi or less and with an articulating arm capable of reaching 15 feet. The desired outcome to prevent detrimental soil conditions and prevent harvest/fuel treatment units from exceeding 20% detrimental soil conditions per Regional and Forest Plan Soil Quality Standards. Applies to fuel reduction and silvicultural activities.
- Retain fine and coarse organic matter on top of the soil. Soil cover should exceed 35%, preferably 50%. The desired outcome is to maintain sufficient amounts of organic matter to prevent short or long-term nutrient and carbon cycle deficits and to avoid detrimental physical and biological soil conditions. Maintain soil cover amounts to prevent soil erosion. Treatment units should be maintained with between 6 to 20 tons per acre of coarse woody material (defined as woody material greater than 3 inches in diameter). Applies to all timber harvest, fuel reduction, and silvicultural activities.
- Target machine pile size to 15 feet in diameter and 10 feet in height outside of landings. The desired outcome is to maintain enough organic matter and to avoid detrimental physical and biological soil conditions. Smaller piles allow for re-colonization by soil organisms and prevent excess tracking from mechanical equipment when creating piles. Applies to all fuel reduction and silvicultural activities.
- Adequately drain firelines including machine and hand line. Waterbars would be installed during fire line construction following guidelines in Fireline Waterbar Guidelines for Prescribed Fires (Jimenez, 2013) and would be described in Elements 5 and Element 9 of the burn plan(s). The desired outcome is to prevent soil erosion from firelines, preserve soil organic matter, and allow for re-vegetation of firelines. Applies to prescribed fire operations.

6.2.1.2 Unit Specific Design Features

- For ground-based units with 10% detrimental soil conditions or greater, practices would be included for some units to ensure that cumulative detrimental soil conditions would remain at or below 20%.
    - Conduct timber harvest when soil is covered by 8 inches of compacted snow or 8 inches of frozen soil or a combination of two that totals 8 inches. This condition should be present on approximately 90% of the timber harvest unit **or**
    - Conduct timber harvest using cut to length logging systems where stand density supports covering forwarder trails with 8 inches of compacted slash **and**
    - Reuse any existing skid trails, landings, and road templates.

Units where these practices should be implemented: **11, 26, 29, 54, 55**

- Landings should not be placed in areas designated as prime farmland. Soil scientist should be contacted to confirm the location of prime farmland during layout if required.

Units where these practices should be implemented: **27**

6.2.1.3 Required Monitoring

There is no required monitoring related to soil resource for this project.

6.2.2 Direct and Indirect Effects for Proposed Action

Table 6. Resource indicators and measures for Proposed Action – direct and indirect effects

Resource Element	Resource Indicator	Measure	Proposed Action Direct and Indirect Effects
Soil Function	Detrimental Soil Conditions	Extent in Activity Areas	1000 Acres
Soil Erosion	Surface Soil Erosion and Landslide Potential	Potential for Detrimental Surface Soil Erosion and Detrimental Mass Soil Movement	Moderate (short-term 0 to 5 years) Low (long-term 5 to 50 years) with recovery of soil cover.
Soil Organic Matter	Depth of Forest Floor, Quantity of Fine and Coarse Wood	Potential for Soil Fertility and Soil Function Issues Due to Lack of Organic Matter Inputs	Low
Watershed Function	Area of Proposed for Disturbance of Hydrologic Function – New System and Temporary Road Construction	Acres of Additional System and Temporary Road minus Areas of Hydrologic Function Restoration (Road Decommissioning)	-70 Acres *There is a net positive benefit to watershed function of 70 acres.*

6.2.2.1 Spatial and Temporal Context for Effects Analysis

The spatial context for the effects analysis for soil function, soil erosion, and soil organic matter would be the activity area of the proposed actions as defined by Region 6 Soil Quality Standards and Guidelines (USDA Forest Service, 1998, p. 6). Watershed function is analyzed on the HUC 6 watershed scale.

The temporal context for effect is short term relative to soil productivity and soil quality is five to twenty years, which pertains to soil erosion and soil cover replacement. Long-term temporal effect is 20 to 100 years and pertain to soil compaction, soil displacement, soil nutrient status, and coarse woody material recovery. Short- and long-term timeframes apply to watershed function.

6.2.2.2 Soil Function - Detrimental Soil Conditions

Mechanical Vegetation Treatments (Including Road Construction)

Soil compaction would increase over the short term and long term but remain within Regional Soil Quality Standards and Guidelines with project design features presented in **Section 7.1**. Commercial timber harvest with ground-based equipment would increase soil compaction (Alexander and Poff, 1985) but management requirements would limit increases. Decreases in soil porosity from compaction should not negatively affect tree productivity (Powers, 2002).

Modeling of project treatments show an increase in soil erosion and loss over the short term (less than 2 years) but with project design features dictated in **Section 7.1**, soil erosion would return to background levels within 3 years (Elliot, 2005). Soil disturbance monitoring protocol surveys show a low occurrence of bare soil and forest floor depths that average **2 inches** or greater in a majority of the units. Detrimental erosion from timber harvest units is not frequent or widespread with current harvest practices and best management practices (Litschert and MacDonald, 2009). Field observations and monitoring on the Colville National Forest has not identified substantial erosion from recent timber harvest units (Jimenez, 2019b).

Road construction would remove soil from productivity on approximately **40** acres.

Prescribed Fire

Monitoring of prescribed fires on the Colville National Forest shows less than two percent detrimental soil conditions. High and moderate soil burn severity is typically less than 3% of measured transects and does not represent a threat to soil productivity or soil quality. Existing roads and natural features are typically used as control lines. Hand line and machine line typically represents less than 1% of the unit. Water control structures would be installed on hand line to prevent soil erosion.

Other Proposed Actions

Other proposed actions will not measurably increase detrimental soil conditions in the analysis area. These other proposed actions include hand piling and aquatic restoration activities.

6.2.2.3 Soil Erosion – Surface Soil Erosion and Landslide Potential

Mechanical Vegetation Treatments (Including Road Construction)

When trees are cut, the root system begins to decay, and the soil-root fabric progressively weakens. The loss of root strength or increased soil moisture or both after tree removal can lower the slope safety factor sufficiently that a moderate storm with an associated rise in pore water pressure can result in slope failure. (Swanson, 1974) After trees are removed, the frequency of landslides can increase (Ziemer, 1981). Steep slopes (greater than 35%) with shallow soils and heavy removal of the over story vegetation increase the risk for landslides. Partial cutting, the provision of leave areas (skips), and the retention of understory vegetation help minimize landslide potentials (Dhakal and Sidle, 2003). Areas of high potentials for slope stability failures have been reviewed and evaluated for the treatment units, there is a low potential risk for slope stability failures to exceed Regional Soil Quality

Standards and Guidelines or Forest Plan standards. This is due to the soils and geology of the project area and the lack of large group selection areas.

Prescribed Fire

Prescribed fire is not expected to influence slope stability. Fires are prescribed at low to moderate severities, tree mortality and enhanced soil moisture from reduced vegetation is not expected to increase soil moisture to a degree at which the potential for landslides/debris flows is increased. Tree mortality would also not be substantial enough to affect root structure across the landscape. Understory vegetation recovery would support slope stability.

Other Proposed Actions

Other proposed actions will not measurably increase surface soil erosion and landslide potential in the analysis area. These other proposed actions including road decommissioning, silvicultural treatments, and aquatic restoration activities.

6.2.2.4 Soil Organic Matter

Mechanical Vegetation Treatments (Including Road Construction)

Mechanical vegetation treatments will displace, lower, and remove accumulations of soil organic matter through disturbance and increased soil respirations due to bare soil, high soil temperatures, and increased solar radiation into stands and the forest floor. Depending on stand conditions some treatment may add additional fine and coarse wood to the forest floor. These effects will not be outside the thresholds for Forest Plan and Regional Soil Quality Standards.

Road construction would displace topsoil for the footprint of the road and remove soil organic matter. Road footprint would be removed from soil productivity and the growing of vegetation. This will be a long-term effect to soil organic matter in these areas.

Prescribed Fire

In the short term, forest floor depth and fine wood would be reduced but monitoring indicates that level is not outside of thresholds for Forest Plan and Regional Soil Quality Standards. Long term addition of soil carbon in the form of charcoal would benefit soil carbon storage and long-term carbon sequestration. Areas of fire dependent ecosystems would be returned to conditions more within the historic range of variability for organic matter deposition and amounts on the landscape. Overall, amounts of organic matter would be reduced but soil nutrient cycling, and soil function would be improved by restoring stands to within their historic range of variability.

Other Proposed Actions

Other proposed actions will not measurably increase or decrease soil organic matter in the analysis area. These other proposed actions including road decommissioning, silvicultural treatments, and aquatic restoration activities.

6.2.2.5 Watershed Function

Mechanical Vegetation Treatments (Including Road Construction)

Mechanical vegetation treatments will increase soil compaction across the landscape as well as add additional soil rutting and small-scale disruptions in lateral soil hydrology across the landscape. Effects will be within Regional and Forest Plan Soil Quality Standard and Guidelines and will protect soils in the long term. Design features detailed in Section **7.1** will assist in maintaining those above standards.

Road construction would compromise watershed function but would be offset but the restoration treatments proposed. Road construction removes soil hydrologic function both horizontally and vertically across a landscape. Roads interrupt the hydrology of hillslopes and concentrates water at unnatural pour points increasing soil erosion and distributing water differently across the landscape. In the short-term watershed function would decrease. Post project implementation and in the long-term watershed function overall will be maintained.

Prescribed Fire

Prescribed fire treatments would increase resiliency to high severity wildfire. High severity wildfire would detrimentally effect soil function and water quality.

Other Proposed Actions

These other proposed actions include road decommissioning, silvicultural treatments, aquatic restoration activities, and meadow restoration. Restoration activities will increase watershed function over the long term and protect watershed values over the short and long term. Other proposed actions will not measurably effect watershed function in the analysis area.

6.2.2.6 Other - Nutrient Cycling, Filtering and Buffering, and Soil Carbon Storage

Mechanical Vegetation Treatments (Including Road Construction)

With commercial timber harvest prescribed, there is a potential for losses in soil organic carbon and soil organic matter but not in amounts that would reduce soil quality and soil productivity (Johnson and Curtis, 2001; Powers, 2002) With design criteria stated, treatments would increase decomposition and facilitate increased inputs of soil organic matter into the soil profile through slash, coarse woody material, and root decomposition with design criteria in Section 3.4 (Brown et al., 2003).

Prescribed Fire

Soil nutrient status would be increased, soil acidity decreased both positive effects. Approximately 10% of soil nitrogen would be lost through prescribed fire; research has shown no significant impact to forest productivity with these losses from prescribed fire (Johnson et al., 2005). There would be a short-term reduction of soil organic matter, approximately 5% decrease (Johnson and Curtis, 2001). There will be an increase in stable carbon from the flux of charcoal added to the soil surface and forest floor. This short-term reduction is within Soil Quality Analysis Standards and would have no effect on long-term soil productivity and soil quality. Over the long term, prescribed fire would increase soil organic matter and nutrient cycling over pre-fire levels (Certini, 2005). Prescribed fire has minimal effects on soil or water quality (Murphy et al., 2006). Soil carbon is increased in the short and long term as well as carbon being protected in large tree boles by prescribed fire treatments.

Other Proposed Actions

These other proposed actions include road decommissioning, silvicultural treatments, aquatic restoration activities, and meadow restoration. Restoration activities will increase watershed function over the long term and protect watershed values over the short and long term. Other proposed actions will not measurably effect watershed function in the analysis area.

6.2.3 Cumulative Effects for Proposed Action

Table 7. Resource indicators and measures for Proposed Action – cumulative effects

Resource Element	Resource Indicator	Measure	Proposed Action Cumulative Effects
Soil Function	Detrimental Soil Conditions	Extent in Activity Areas	No Cumulative Effects
Soil Erosion	Surface Soil Erosion and Landslide Potential	Potential for Detrimental Surface Soil Erosion and Detrimental Mass Soil Movement	Low – (No Change)
Soil Organic Matter	Depth of Forest Floor, Quantity of Fine and Coarse Wood	Potential for Soil Fertility and Soil Function Issues Due to Lack of Organic Matter Inputs	Low – (No Change)
Watershed Function	Area of Proposed for Disturbance of Hydrologic Function	Acres of Additional System and Temporary Road minus Areas of Hydrologic Function Restoration (Road Decommissioning)	Not Applicable

6.2.3.1 Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Effects of past and present activities are discussed in the existing condition, **Section 5.0**. The existing condition described in the analysis incorporates all past actions that have occurred within the analysis area as described in Summary of Past, Present, or Reasonably Foreseeable Activities Within and Adjacent to the Timber Mountain Analysis Area document present in the project file.

6.2.3.2 Cumulative Effects of Proposed Action – The Resource Elements and Resource Indicators

There are no other activities in the reasonable foreseeable future (defined for this analysis as projects decided and waiting for implementation, in any stage of planning, or listed on the out-year plan, or listed in the Schedule of Proposed Actions on the Colville National Forest website) that are expected to substantially increase the detrimental soil condition in the project area. There is no overlap in time and space. Effects are described in the direct and direct effects in the previous sections.

There are no quantifiable cumulative effects because of the proposed action in terms of Soil Function, Soil Erosion, and Soil Organic Matter resource elements. This is due to the bounding of the analysis on the activity area.

There are cumulative effects for Watershed Function resource element using the resource indicator of "Area proposed for Disturbance of Hydrologic Function" due to the definition of the resource indicator. In general, the addition of system and temporary roads to the Big Muddy and Sweet-Pend Oreille River watersheds in combination with the existing road system and the road features that are proposed for decommissioning will lower

watershed function for the short term. In the long term, watershed function will return to current condition or improve in condition.

7.0 Summary

7.1 Degree to Which the Purpose and Need for Action is Met

The soil resource is not directly related to the purpose and need of the project and was not identified during scoping as a resource that should be included in the purpose and need.

7.2 Degree to Which Alternatives Address the Issues

No alternatives were selected for detailed analysis other than the proposed action. There are no issues related to the soil resource.

7.3 Summary of Environmental Effects

Detrimental soil conditions will increase to thresholds that are below Regional and Forest Plan Soil Quality Standards. Ground based timber harvest units with grapple piling treatments will approach 18% detrimental soil conditions that will recover over the short and long-term depending on the degree of site-specific disturbance. Most units of mechanical treatment will remain under 15% detrimental soil condition with the majority of the detrimental disturbance from soil compaction followed by soil rutting (conditions defined by Soil-Disturbance Field Guide (Napper et al., 2009)). Soil erosion is not expected to increase in a measurable way. There will be short-term negative effects to soil function and soil productivity, but overall soil conditions and long-term effects will be beneficial as forest stands return to historic and natural range of variability via thinning and prescribed fire treatments.

Watershed restoration treatments will have beneficial effects to watershed function and detrimental soil conditions. Restoration treatments with beneficially effect approximately **750** acres with approximately 30 additional restoration actions. Sites with culvert replacement and stream channel treatments will repair and increase watershed function with little to no increases to detrimental soil conditions. Areas with road decommissioning will be areas returned to productivity and vertical hydrologic function will be restored. Hydrologic connection of the landscape will be restored over the long term; >100 years.

The construction of **8** miles of new temporary roads will inhibit soil productivity on approximately 40 acres (estimated 30 feet impact width) for the long term; >50 years. The new system roads will disconnect hillslopes from hydrologic function across the landscape. The road prism interrupts and diverts horizontal flow of water through the soil, negatively affecting water flow and availability on the landscape. The new temporary roads will also create areas of detrimental soil erosion as flows are concentrated and then diverted off the road prism. These effects are long term on the landscape; 40 to 100 years depending on site specific attributes.

Road construction will impact approximately 0.25% of the analysis area (**40** acres) or approximately 0.40% of the treatment area prescribed for ground-based equipment. The utilization of the Smack Out Gravel Pit will remove 5 acres from soil productivity.

The road decommissioning of 9.5 miles will restore approximately **60** acres (estimated 50-foot restoration width), with hydrologic function being restored in the short term and detrimental soil conditions being restored in the long term. The additional obliteration of 8 miles of authorized roads will restore approximately **40** acres (estimated 40-foot restoration width).

7.4 Compliance with Colville National Forest Land and Resource Management Plan and Other Relevant Laws, Regulations, Policies, and Plans

The proposed action would meet soil management goals, maintenance of soil quality, and limit detrimental soil condition. The proposed project action complies with the standards and guidelines described in the Forest Service Manual and Handbook, Region 6 Soil Quality Standards (1999), and Colville National Forest – Land Management Plan (1988).

It is my determination that the proposed action would not detrimentally degrade soil resources beyond above stated guidelines due to treatment prescriptions and characteristics of the landscape involved. Negative direct, indirect, and cumulative effects would be limited with the design criteria and best management practices described. This analysis and report represent my best professional judgment based on my observations of the project area, quantitative and qualitative data collection, consultation with other resource professionals, and a review of the best available science.

8.0 Other Relevant Mandatory Disclosures

8.1 Intensity Factors for Significance (FONSI) (40.CFR 1508.27(b))

Factor 1: Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

The proposed action alternative **does not** exceed a threshold for direct, indirect, or cumulative effects that would be significant for soil quality, soil function, or soil productivity as well as watershed function.

*Factor 3: Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands**, prime farmlands**, wetlands, wild and scenic rivers, or ecologically critical areas.*

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. The land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed according to modern farming methods. (*Soil Survey Manual*, 1993).

Prime farmlands do not need to be currently under cultivation or have a history of cultivation. Prime farmland is defined by a criterion of nine different soil characteristics including soil moisture regime, soil temperature regime, soil texture, and soil chemistry. **There is approximately 50 acres of Prime Farmland within the planning area**. Of these acres, 4 acres lay within commercial harvest unit boundaries. Martella ashy silt loam, a designated prime farmland soil in the southern edge of unit 27. Most of the area is within a non-commercial ground-based treatment unit for an aquatic wood source. There is low potential of degradation of soil productivity within these areas due to the small size of the area, low slopes gradients, these areas will be restricted from use as landing locations. Refer to Unit Specific Design Features **7.1.2**.

Factor 10: Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

There is no proposed action related to or effecting the soil resource or watershed function that threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

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10.0 Appendix A –

SUMMARY OF DETRIMENTAL SOIL CONDITIONS (D0, D1, D2, D3) PER STAND/TIMBER UNIT

Unit ID	Detrimental Soil Condition	Total Points Collected	D0	D1	D2	D3	Forest Floor Depth (cm)	Fine Wood	Coarse Wood	Live Plant	Bare Soil	Rock
1	3%	30	83%	13%	3%	0%	7.8	100%	10%	47%	0%	0%
2	7%	30	83%	10%	3%	3%	5.3	97%	10%	60%	3%	0%
3	0%	30	90%	10%	0%	0%	2.9	87%	23%	50%	3%	3%
4	0%	30	77%	23%	0%	0%	4.6	83%	17%	60%	0%	13%
5	3%	30	77%	20%	3%	0%	5	93%	3%	47%	0%	0%
6	3%	30	77%	20%	3%	0%	3.6	70%	7%	70%	0%	3%
7	0%	30	83%	17%	0%	0%	3	97%	23%	67%	3%	7%
8	0%	30	97%	3%	0%	0%	3.6	90%	7%	80%	0%	3%
9	0%	30	97%	3%	0%	0%	3.4	77%	13%	83%	3%	0%
10	3%	30	73%	23%	0%	3%	3.7	93%	20%	67%	3%	0%
11	15%	59	58%	27%	15%	0%	1.9	76%	7%	44%	2%	0%
12	0%	15	100 %	0%	0%	0%	4.3	93%	47%	67%	0%	0%
13	0%	30	90%	10%	0%	0%	3.6	97%	13%	70%	3%	0%
14	0%	15	100 %	0%	0%	0%	2.9	93%	27%	67%	0%	0%
15	3%	30	53%	40%	3%	0%	4	87%	10%	77%	0%	0%
16	7%	30	83%	10%	7%	0%	4.5	73%	13%	50%	10%	0%
17	0%	30	77%	23%	0%	0%	2.8	67%	10%	70%	0%	3%
18	7%	30	67%	27%	3%	3%	1.8	37%	10%	90%	3%	0%
19	3%	30	77%	20%	0%	0%	3.1	97%	23%	67%	0%	0%
20	3%	30	77%	20%	3%	0%	2.5	57%	10%	67%	3%	0%
21	0%	30	90%	10%	0%	0%	1.7	93%	23%	63%	0%	0%
22	0%	30	97%	3%	0%	0%	2.5	90%	20%	60%	0%	0%
23	3%	30	83%	13%	3%	0%	5.7	100%	17%	67%	0%	0%
24	0%	30	90%	10%	0%	0%	5.3	93%	13%	70%	0%	0%
25	7%	15	73%	20%	7%	0%	4.5	87%	13%	87%	7%	0%
26	10%	30	60%	30%	7%	3%	2.8	77%	17%	43%	3%	0%

27	3%	30	70%	27%	3%	0%	2.8	83%	10%	60%	0%	0%
28	0%	30	100 %	0%	0%	0%	2.8	97%	13%	93%	0%	7%
29	10%	30	77%	17%	7%	0%	2.8	93%	7%	57%	0%	17%
30	0%	30	87%	13%	0%	0%	3.8	86%	10%	50%	7%	30%
31	7%	30	73%	20%	7%	0%	2	63%	3%	90%	7%	17%
32	0%	30	100 %	0%	0%	0%	2	80%	3%	27%	3%	7%
33	7%	30	73%	20%	7%	0%	1.8	83%	20%	93%	0%	0%
34	0%	30	93%	7%	0%	0%	3	83%	10%	80%	0%	0%
35	0%	30	90%	10%	0%	0%	4.4	93%	27%	67%	0%	0%
36	3%	30	63%	27%	10%	0%	3.7	80%	23%	83%	0%	0%
37	3%	30	90%	7%	3%	0%	3.2	90%	10%	83%	0%	0%
38	3%	30	77%	17%	3%	3%	2.9	97%	20%	87%	0%	0%
39	3%	30	73%	23%	3%	0%	4.3	93%	20%	63%	3%	3%
40	3%	30	87%	10%	3%	0%	3	93%	13%	67%	0%	0%
41	3%	30	70%	27%	3%	0%	3.5	100%	20%	67%	0%	0%
42	0%	30	90%	10%	0%	0%	3.3	97%	23%	83%	0%	0%
43	0%	30	90%	10%	0%	0%	4.3	87%	0%	67%	3%	0%
44	0%	30	100 %	0%	0%	0%	3.9	97%	28%	77%	0%	7%
45	7%	30	77%	17%	7%	0%	7.1	100%	23%	30%	0%	3%
46	0%	30	87%	13%	0%	0%	5.2	100%	27%	47%	0%	0%
47	0%	30	93%	7%	0%	0%	6.6	97%	33%	30%	0%	0%
48	7%	30	83%	10%	7%	0%	5.5	93%	13%	83%	0%	0%
49	3%	30	80%	17%	3%	0%	5.6	90%	27%	33%	0%	0%
50	3%	30	60%	33%	7%	0%	6.3	93%	40%	50%	0%	0%
51	3%	30	80%	17%	3%	0%	4.3	93%	13%	53%	0%	0%
52	3%	30	87%	10%	3%	0%	4.9	97%	27%	47%	0%	0%
53	3%	30	83%	13%	3%	0%	2.7	93%	10%	50%	3%	7%
54	10%	39	90%	3%	8%	0%	7.3	97%	21%	21%	0%	0%
55	11%	45	80%	9%	11%	0%	4.4	87%	20%	56%	0%	0%
56	3%	30	80%	13%	7%	0%	4.5	100%	27%	27%	0%	0%
57	0%	30	83%	17%	0%	0%	5.4	87%	13%	57%	0%	0%

58	7%	30	70%	23%	7%	0%	3.5	97%	37%	50%	0%	0%
59	0%	30	87%	13%	0%	0%	3.5	93%	10%	50%	0%	0%
60	3%	30	77%	20%	3%	0%	2.5	87%	10%	53%	3%	0%
61	0%	30	80%	20%	0%	0%	3.4	80%	17%	67%	0%	0%
62	0%	30	87%	13%	0%	0%	4.5	100%	3%	97%	0%	3%
63	3%	30	80%	17%	3%	0%	4.1	97%	23%	73%	0%	0%
64	3%	30	83%	13%	3%	0%	4.9	93%	20%	70%	3%	0%
65	0%	30	97%	3%	0%	0%	3.9	90%	10%	87%	0%	3%
66	0%	30	87%	13%	0%	0%	5.4	100%	13%	63%	0%	0%
67	7%	30	70%	23%	7%	0%	3.7	93%	13%	60%	3%	3%
68	0%	30	97%	3%	0%	0%	3.6	77%	10%	53%	0%	0%
69	8%	36	69%	22%	8%	0%	4.6	94%	11%	78%	0%	0%
70	0%	30	90%	10%	0%	0%	4.5	93%	3%	53%	0%	0%
71	3%	30	67%	30%	3%	0%	3.1	87%	13%	40%	0%	0%
72	3%	30	87%	10%	3%	0%	3.3	87%	10%	60%	0%	3%
73	3%	30	97%	0%	3%	0%	5.6	87%	3%	30%	0%	0%
74	8%	36	89%	3%	8%	0%	5.6	94%	25%	39%	0%	3%
75	3%	30	77%	20%	3%	0%	5.6	97%	30%	73%	0%	3%
76	7%	30	77%	17%	7%	0%	3.1	100%	13%	20%	0%	3%
77	7%	30	87%	7%	7%	0%	3.7	100%	23%	53%	0%	0%
78	3%	30	83%	13%	3%	0%	4	90%	27%	93%	0%	0%
79	0%	30	90%	10%	0%	0%	4.7	100%	10%	60%	0%	3%
80	3%	30	80%	17%	3%	0%	2.3	80%	10%	90%	0%	0%
81	7%	30	83%	10%	7%	0%	5.1	100%	33%	57%	0%	0%
82	0%	30	80%	20%	0%	0%	3.2	87%	33%	57%	3%	3%
83	3%	30	83%	13%	3%	0%	3.5	97%	20%	53%	0%	7%
84	7%	30	80%	13%	7%	0%	3.6	93%	17%	67%	0%	0%
85	7%	30	80%	13%	7%	0%	3.5	100%	17%	73%	0%	0%
86	7%	30	77%	17%	7%	0%	3	97%	3%	50%	0%	0%
87	3%	30	73%	23%	3%	0%	3	80%	7%	47%	0%	0%
88	3%	30	97%	0%	3%	0%	3.7	90%	7%	37%	0%	0%
89	3%	30	90%	7%	3%	0%	4.9	97%	30%	53%	0%	0%
90	0%	30	100	0%	0%	0%	4.4	97%	27%	53%	0%	0%

			%									

Note: Highlighted units have elevated existing soil disturbance.

11.0 Appendix B –

SUMMARY OF WETLAND FUNCTION

Wetland ID	Acres	Functional Rating	Comments
0621-05-161	11	Not a Wetland	No hydric soils, invasive plants, some trampling. Riparian area.
0621-05-200	1	Functional	Road. Grazing, animal (wild and livestock) trails, and trampling.
0621-05-173	2	Functional	Invasives minor. Road intersects wetland, disturbing natural movement of water.
0621-05-141	3	Not a Wetland	Cottonwood trees and other wetland vegetation dominate, mostly a riparian area.
0621-05-174	2	Functional-At Risk	Invasives sparse. No groundwater influence detected. Well drained soil: mucky layer saturated with decomposed fiber/OM. Evidence of compaction and grazing from livestock that is changing water flow. Presence of upland species (snowberry).
0621-05-150	4	Functional	Transitional zone with patches of hydric soils but mostly wetland/upland transition. Canadian thistle observed. Grazing.
0621-05-178	1	Functional	Cattle trampling outskirts of wetland.
0621-05-155	2	Functional	Some trampling and trails present.
0621-05-156	1	Functional	Some trampling and trails present.
0621-05-153	2	Functional	Campsite adjacent to wetland, upslope.
0621-05-182	7	Functional	All indicators could not be properly assessed, snow on ground.
0621-05-150	4	Functional	Grazing, trampling, and trails by animals.
0621-05-148	4	Functional	Grazing, trampling, and trails by animals.
0621-05-144	48	Functional	Grazing, trampling, and trails by animals. Trace thistle observed.